

Recent advances in the surgical management of urinary stones in Nigeria

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ABSTRACT

From 2017 to the present, there has been considerable interest and efforts geared toward replacing open surgical treatment of urinary calculi in the Nigerian government's public healthcare system with minimally invasive lithotripsy approaches. This article is a brief review and commentary on both the progress that has been made in the public teaching hospitals, and the epidemiology, natural history, causes, clinical features, diagnosis, and surgical options in the management of kidney, ureteral, and bladder calculi. The definition, nature, models, and role of lithotripsy were described. The latter part of the article gives a contemporaneous account of the time trends in the development of lithotripsy in public teaching hospitals. Lastly, the areas for development in the future, within the government's public teaching hospital system were outlined.

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INTRODUCTION

Urinary stones are concretions that for illustration purposes may be described as sand or gravel particles. Stones form gradually inside the kidney, where they may remain or subsequently migrate downstream with urine into the ureters or the urinary bladder. Stones may also be formed within the urinary bladder. Thus, urinary stones may be found in the entire urinary tract from the kidneys to the urethra. Stones can be found in both adults and children. Depending on the stone location within the urinary tract, they are described as kidney stones (nephrolithiasis), ureteric stones, bladder stones, or urethral stones. The stone disease spectrum is described as urolithiasis.

Epidemiology

The prevalence of kidney stones worldwide varies between geographic locations ranging from 7–10% in the USA, 5–9% in Europe, and 1–5% in Asia (Sorokin et al., 2017). In Nigeria, a hospital incidence of 19.1 per 100,000 and male:female ratio of 2.7:1 was reported in South-Eastern Nigeria in 1995 (Ekwere, 1995). There is a once-in-a-lifetime risk of developing urolithiasis in 10% of the world population and in 2% it is recurrent (Sorokin et al., 2017; Wagner, 2021).

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Diet is a major predisposing factor. The type of stone that is formed depends on the composition of urine which reflects the diet in the community; diets that are nutritionally poor, low in animal protein, calcium, phosphate, and dehydration may predispose to stones in children and young adults. Increased intake of cereals may predispose to acidogenic urine which has a high content of ammonium and urate. Increased intake of oxalates from green leaves and vegetables predisposes to urinary oxalate stones. With increasing affluence and change in diet, the pattern of urinary stones changes to calcium phosphate, calcium oxalate, and uric acid (Robertson, 2003).

Infection is a predisposing factor, accounting for up to 15% of cases. Some bacteria (*Proteus mirabilis*, *Ureaplasma urealyticum*, *Corynebacterium urealyticum*, and some other gram-positive and negative organisms) produce the enzyme urease that split urea into ammonia and carbon dioxide resulting in urinary alkalization, phosphate salts and formation of Magnesium Ammonium

Phosphate (Struvite) stones and carbonate apatite stones which are the infection stones (Bichler et al., 2002; Thomas & Tolley, 2008).

Aside from environmental factors, the role of genetics in the pathogenesis of stones, especially nephrolithiasis and idiopathic hypercalciuria is increasingly being recognized. Over 45% of nephrolithiasis and more than 50% of hypercalciuria are estimated to have a genetic basis (Howles & Thakker, 2020; Halbritter, 2021).

Natural history of urinary stones

Stones that have migrated into the ureters and bladder from the kidneys or formed within the bladder may be voided with urine. The chances of spontaneous stone passage, SSP for stones measuring less than 5mm on non-enhanced Computerized Tomography, CT scans are up to 98%; while for stones over 5mm in size or located in the proximal ureter the chance of SSP is much less (Jendeberg et al., 2017; Shah et al., 2019). Consequently, a significant number of stones over 5mm require surgical treatment. There are different approaches and options to the surgical management of urinary stones. Regardless of stone size, location, and depending on chemical composition, there are also non-surgical or medical treatment options.

Causes of urinary stones

There are a variety of causes and risk factors for the formation of urinary stones (Jung et al., 2017; Mohebbi, 2021). These include but are not limited to infections due to bacteria or parasites, insufficient intake of or excessive loss of fluids, excessive intake of soda drinks, and poor or unbalanced diet (excessive intake of milk, red meat, and green vegetables). Certain medical conditions such as obesity, diabetes, gout, and overactive parathyroid glands (hyperparathyroidism), may cause or predispose to stone formation. Stones may arise as a complication of having treatment with some drugs. Stones that occur in children or teenagers may be a manifestation of inherited metabolic conditions such as cystinuria and renal tubular acidosis. Obstruction to urinary flow resulting in stasis or pooling of urine may result in stone formation in the kidneys, ureters, or bladder.

Clinical features and diagnosis of urinary stones

The clinical features depend on the stone's location and size. The symptoms of urinary stones are due to pressure on and distension of the urothelium, varying degrees of obstruction to urine drainage, infection, and other features of the underlying

disease (Marberger, 1999). Stones within the kidneys may be asymptomatic or manifest with symptoms of flank pain, haematuria, and when infected, fever.

Ureteric stones may be asymptomatic or cause acute or chronic flank pain, haematuria (visible and invisible), and fever in cases of associated infection. Stones located in the distal ureters may cause a referred sensation of pain to the pelvis, urethra, upper thigh, and urinary frequency.

Bladder stones may cause pelvic pain, haematuria, urinary symptoms, referred pain to the penile tip in men, and fever in some cases of infection.

In children, the symptoms are usually non-specific. They may present with abdominal pain, haematuria, and fever. In all cases where the symptoms are neglected or treatment not sought early, varying degrees of renal damage may occur. In complicated cases, the patients may present with obstruction to urinary drainage, severe infection, and even renal failure which may or not be reversible.

Patients with stones may on occasion notice spontaneously voided stones.

Urinary stones may be of varying sizes from less than 5mm to over 2–3 cm. In some instances, the urinary stones may partially or completely occupy the renal pelvis with extensions into one or more calyces, a condition clinically described as a partial or staghorn stone.

The diagnosis of renal tract stones is confirmed with imaging studies, plain abdominal x-ray, renal tract ultrasound scan, and CT scan of the kidneys, ureters, and bladder, CTKUB. Most stones are detectable on plain KUB x-ray and non-enhanced CT KUB, although the latter has higher sensitivity and clinical utility in the information obtained. Stones composed of uric acid and indinavir may not be visible on CT imaging. Under these circumstances, the ultrasound scan is the diagnostic tool to locate the stone (Wu & Stoller, 2000; Kluner et al., 2006; Yap et al., 2012).

Metabolic evaluation of the patient with urinary, blood tests, and chemical analysis of the stones helps to determine the chemical composition. Genetic testing is not yet available. Based on the information obtained, stone dissolution therapy, where feasible and preventive measures can be determined.

Options in the management of kidney stones in Nigeria

Urologists have treated kidney stones in diverse ways for over a century. With advancements in surgical science, training, instrumentation, and modern technology to crush and retrieve stones,

there have been improvements in the approach to management and treatment outcomes. While small asymptomatic stones measuring less than 5mm may be observed while watching out for SSP, small stones which are causing symptoms and larger stones require treatment. The treatment of a stone, whether small or large, depends on the available technology in the hospital and the experience of the urologist.

Historically, in Nigerian teaching hospitals, due to either lack of skill or relevant equipment, the main approach to the treatment of urinary stones was open surgery (Ekwere, 1995) which requires a big incision in the abdomen and prolonged post-operative stays in the hospital for recovery.

However, over the last 5–8 years, the situation has been progressively changing across the country due to the increasing availability of medical stone crushing or Lithotripter machines. It is now possible to treat stones located within the kidneys, ureters, and bladder with a laser fibre connected from the laser device to the stone location through an endoscopic (ureteroscopic) approach or a percutaneous approach through a tiny incision in the flank. As a result, recovery is quick, compared to the open surgical approach and the hospital stay is short. Consequently, the frequency of open stone surgery in Nigeria is gradually declining and is now mainly required for large and complicated stones.

What is lithotripsy?

Lithotripsy simply means stone fragmentation. The prefix laser implies the use of laser light energy to achieve lithotripsy. There are a variety of lithotripters or stone-crushing devices with names that prefix lithotripsy. Examples are Pneumatic (mechanical) lithotripsy, Holmium laser lithotripsy, and Thulium laser lithotripsy. Holmium laser is the current gold standard. The Thulium laser is similar but with different characteristics and is still under clinical evaluation (Traxer & Keller, 2020; Ulvik et al., 2022). All the Lithotripters crush stones into tiny bits that can be either physically removed with tiny baskets during the operation or left to be spontaneously voided with urine later.

Lithotripsy technology was developed in the 1960s and introduced to clinical practice about a decade later (Kronenberg & Somani, 2018; Traxer & Keller, 2020). Since then, to achieve efficiency and efficacy in stone fragmentation, there have been several generations of lithotripters. The electrohydraulic (or pneumatic) and electromagnetic devices respectively were the forerunners before the introduction of the Holmium laser in the 1980s – 1990s (Traxer &

Keller, 2020). Since then, there have been rapid advances with the later development of the Thulium laser and wide acceptance by urologists all over the world.

Trends in the Development of Lithotripsy in Nigerian Teaching Hospitals

The first ureteroscopic lithotripsy using a pneumatic lithotripsy device was performed at the University of Benin Teaching Hospital, UBTH by the author on 13 June 2017. In December 2017, Holmium laser lithotripsy was first performed in UBTH during the Workshop of the Nigerian Association of Urological Surgeons, NAUS using a device provided by a manufacturer. In 2019, UBTH officially acquired a Holmium laser machine. The first ureteroscopic Holmium laser lithotripsy using the UBTH Holmium device was performed by the author on 09 December 2020. Since then, it has been routinely performed in the hospital. Prior to the dates of acquisition and the first use of the Holmium laser machine respectively in UBTH, no other teaching hospital in Nigeria was known to have acquired a Holmium laser machine or performed lithotripsy using a Holmium laser device. However, lately, some teaching hospitals have acquired lasers of either the Holmium or Thulium variety.

Conclusions and the Future

Urolithiasis is a disease in which the presence of stones is both a symptom and a sign of the underlying condition. Therefore, treatments should be directed at both the stone and the underlying cause.

Ureteroscopy for the surgical treatment of urinary stones is now well established in Nigeria, although there remain challenges with access due to costs, the availability of the necessary ancillary infrastructure, and personnel to support a modern lithotripsy service. Regardless of these barriers, the increasing availability of minimally invasive treatment options for urinary stones with ureteroscopic lithotripsy devices has revolutionized stone surgery in Nigeria.

In the future, percutaneous renal stone surgery and extracorporeal shockwave lithotripsy, ESWL (a procedure where sound waves generated by a machine outside the body are used to fragment stones) in teaching hospital settings are the areas in need of development.

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